PART MOUNTING METHOD, PART MOUNTING DEVICE, AND RECORDING MEDIA
[Buhin jisso hoho oyobi buhin jisso sochi, narabi ni kiroku botai]

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PART MOUNTING METHOD, PART MOUNTING DEVICE, AND RECORDING MEDIA

INDUSTRIAL FIELD

The present invention pertains to part mounting methods and part mounting devices for implementing these part mounting methods. The present invention also pertains to computer-readable recording media for implementing these part mounting methods.

PRIOR ART

Part mounting methods and part mounting devices for mounting parts such as electronic parts in circuit formations, such as typically electronic circuit boards, have several part supply devices fitted with part assemblers disposed in the part supply part of a part mounting device, and successively fetch parts in a predetermined sequence from these several part supply devices to part holding parts. Next, whether this part holding part is holding the part in a posture allowing mounting is detected, and if the result of this detection confirms that this part is in a posture allowing correct mounting, the deviation between the part holding part holding this part and the holding position of this part is detected. A part subject to position correction based on this detection result is mounted in a predetermined position on a circuit formation. In cases such as the part is not in a position allowing correct mounting or the holding position of the part cannot be detected correctly, the part holding part carries out an operation for releasing this part from the holding status and ejecting at a predetermined position without carrying out the operation for mounting this part in a circuit formation.

"Circuit formation" here refers to the substrate on which electronic parts are mounted. This often is an electronic circuit board, but recent substrates have included cases for mounting parts on the case itself of an electronic device. These are collectively called circuit formations in this specification. The following discussion, however, takes the typical case of a substrate to facilitate understanding.

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[*]Numbers in the margin indicate pagination in the foreign text.

In recent years, the trend has been to mount parts at higher
density on substrates, to narrow the mounting spacing of parts on
substrates in response to this, and to make parts even smaller in
response to market demands for smaller and lighter electronic
devices. Therefore, rigorous control of the holding posture of parts
held in part holding parts is required so that mounting the next part
in an adjacent position to a part previously mounted on a substrate
does not obstruct the previously mounted part. There has also been a
trend to make the area of the tip of the part holding parts, such as
nozzles, which hold parts by adsorption smaller to prevent
interference with the part after mounting.

Next, the configuration of a conventional part mounting device
will be discussed by referring to Figs. 5 to 7. Fig. 5 shows an
overall outline of a part mounting device. The part mounting device
in Fig. 5 contains a main part (1) and a part supply part (2). The
main part (1) carries out a series of mounting operations for
fetching a part supplied by the part supply part (2) and mounting
this part on a substrate supplied from the side of the main part (1).

Fig. 6 shows an outline of a part mounting device according to a
part cassette system for supplying parts to a part supply part (2).
In Fig. 6(a), parts (3) are loaded at a specific spacing (5) on a
tape (4), and this tape (4) is wound and loaded on a reel (6). In
Fig. 6(b), the reel (6) is mounted in a part cassette (7), and the
part cassette (7) sequentially feeds the tape (4) at a specific
spacing by operating a lever part (8) so as to position a part (3) in
a part adsorption window (9). Usually, several part cassettes (7) are
mounted in the part supply part (2) of a part mounting device shown
in Fig. 5. The part supply part (2) is configured so as to be moved
back and forth in the X direction in Fig. 5 by driving a motor to
match the part cassette (7) in which a part (3) to be mounted has
been loaded with a specific fetching position. Although a part
cassette system has been indicated here as a part mounting device,
other systems are a bulk feeder system for successively supplying
parts using air, and supply systems using, for example, a tray on
which parts are placed spatially.

Fig. 7 shows an outline of the series of mounting operations
from fetching a part in the main part (1) to mounting on a substrate
in a part mounting device shown in Fig. 5. A part cassette (7) is
attached to the part supply part (2) in back in the Y direction shown
in Fig. 7. As discussed earlier, operating a lever part (8) are
successively supplies parts (3) from a reel (6) mounted in the part
cassette (7) to a part adsorption window (9). Fig. 5 shows a
component (10) which fits into the main part (1) in front in the Y
direction. Index (11) within this has several part mounting heads

(12) distributed along the circumference for adsorbing and mounting parts on a substrate. Driving a motor to intermittently rotate the index (11) in the direction shown by the arrow (13) moves the part mounting heads (12) to the operating positions in succession. Nozzles (14), which are part holding parts attached to the part mounting heads (12), can be moved up and down in the Z direction in Fig. 5 and rotated centered an axis parallel to the Z direction by driving a motor so as to allow these to adsorb and mount parts. A tube is connected to each nozzle (14) to supply negative and positive pressure for adsorbing or releasing parts. A substrate (21) is fed from a circuit formation supply part and adjusted and held by a circuit formation holding device (not shown), and can be moved in a plane in both the X and Y directions in Fig. 5 by driving a motor.

Likewise in Fig. 7, first, a nozzle (14) fetches and adsorbs a part (3) from the part adsorption window (9) of the part cassette (7) in a part fetching position (15) using negative pressure. Next, intermittently driving the index (11) in the direction of arrow (13) moves this nozzle (14) to a following part holding posture judgment position (16), where a part holding posture judgment device (17) judges whether the adsorbed part (3) is in a status allowing mounting. Intermittently driving the index (11) next moves the nozzle (14) to a part holding position detection position (18), where a part holding position detection device (19) detects the adsorption position of the part (3). Intermittently driving the index (11) more moves the nozzle (14) to a following part mounting position (20), where the nozzle (14) is lowered in the Z direction in Fig. 5 to mount the part (3) in a predetermined location on a substrate (21) adjusted and held by a circuit formation holding device driven in both the X and Y directions following predetermined mounting position data (by an NC program).

If the previous part holding posture judgment device (17) is that the holding posture of a part (3) is not a status allowing correct mounting, instead of mounting this part (3) in the part mounting position (20), the nozzle (14) releases the adsorption of the part (3) and ejects this part into a part collecting device (23) when moved to the following part collection position (22). The nozzles (14) of the several part mounting heads (12) distributed on the index (11) are synchronized with the intermittent movement of the index (11) so that the operations of each for adsorbing and mounting or expelling parts as required proceed simultaneously. The reference numbers (25) and (26) in Fig. 7 are a part holding posture judgment /4 controller and a part holding posture recognition controller, respectively. Fig. 7 shows parts (3) enlarged for clarity in each of the nozzle positions starting from the part holding posture judgment position (16).

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Next, an outline of the part holding posture judgment process will be discussed referring to Fig. 8. A part holding posture judgment device (17) such as a line sensor uses, for example, light irradiated by a light projecting side (28) toward a light receiving side (29) to judge the holding posture of a part (3) adsorbed to a nozzle (14). The nozzle (14) is judged to have adsorbed a specific part (3) in a holding posture allowing mounting of this part (3) if the measured height of the part (3) held by the nozzle (14) relative to the height reference face of the light receiving side (29) as shown in the drawing is within the following predetermined permissible range Δh of a predetermined height (h1) = (height h2 of the nozzle (14) – height of the part (3)):

$$(h1 - \Delta h) < h1 < (h1 + \Delta h)$$

If the measurement result is the same as the predetermined height h2 of the nozzle (14), it is judged that a part (3) is not adsorbed to the nozzle (14). If the measurement result h3 is

$$h3 < (h1 + \Delta h)$$

the part is judged to be in a holding posture not allowing correct mounting (hereafter called "adsorbed upright"). If judged to be absorbed upright, this part (3) is ejected into the part collecting device (23) at the part collection position (22) instead of mounting in the part mounting position (20) in Fig. 7. If a part which is not the specific part (3) (and is therefore a part with a different height) has been adsorbed to the nozzle (14), this part is detected in the same way and ejected into the part collecting device (23) at the part collection position (22).

Fig. 9 shows an outline of finding the deviation between the nozzle (14) at the following part holding position detection position (18) and the adsorption position of the part (3). The rectangle shown by solid lines in Fig. 9 shows the adsorption status of the part (3), and the circle shown by dotted lines shows the status of the nozzle (14) adsorbing the part (3). Although the target adsorption position /5 of a part (3) varies depending on factors such as the shape of the part or the dead center position and is predetermined for each part, to facilitate the discussion here, the adsorption position is taken to be the center (31) of the part (3). A part holding position detection device (19) located in a position facing the part holding position detection position (18) of the index (11) shown in Fig. 7 captures the state in which the part (3) is held by the nozzle (14) from below by an image recognition device, and detects the center (31) of the part (3) shown in Fig. 9. As a result, the detection device detects the deviation Δx in the X direction and the deviation

Δy in the Y direction between the already known center (32) of the nozzle (14) and the center (31) of this part (3), and computes the total deviation Δa.

The part holding position detection device (19) simultaneously detects the slope of the part (3) held by the nozzle (14). For example, if the sides of the rectangular part (3) shown in Fig. 9 have a specific slope to a holding posture parallel to the X and Y directions, the part holding position detection device (19) detects this slope α of the part (3).

Next, the production operation by a conventional part mounting device will be discussed referring to Fig. 10. As production starts in step #901 (hereafter, "step" will be omitted and only the step # will be indicated), a substrate (21) is fed to a circuit formation holding device and adjusted in #902, and a part (3) is adsorbed and fetched from the part supply part (2) in #903. In #904, the part holding posture judgment device (17) located facing the part holding posture judgment position (16) detects the holding posture of the part (3), and the part holding posture judgment controller (25) judges the holding posture based on this detection result. If the holding posture of the part (3) is judged to be within a range allowing correct mounting, the routine proceeds to #905, and the part holding position detection device (19) located facing the part holding position detection position (18) and the part holding posture recognition controller (26) detect the center (31), which is the reference position of the part (3), and the deviation Δa between the center (31) of the part (3) and the center (32), which is the reference position of the nozzle (14) (see Fig. 9). These also detect the slope α of the part (3) (see Fig. 9). If both of these were detected correctly, the position and slope of the held part (3) are corrected based on this deviation Δa and this slope α in #906, the part is positioned for mounting on the substrate (21) in the part mounting position (20) in #907, and this part (3) is mounted in #908.   /6
Next, #909 judges whether this is the last mounting point; that is, whether all parts (3) to be mounted have been mounted. If judged to be the last mounting point, #910 then judges whether this substrate (21) is the last substrate. If judged to be the last substrate, this substrate (21) is expelled in #911 and the production operation ends.

If the part holding posture judgment in #904 is that the part is not yet adsorbed, instead of carrying out the mounting operation in the next part mounting position (20), the part adsorption operation of #903 is repeated after rotating the index (11) one time. If the part holding posture judgment in #904 is that the part has been adsorbed upright, the part (3) is ejected into the part collecting device (23) in the part collection position (22) in #912, then the

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part adsorption operation of #903 is repeated after rotating the index (11) one time.

If the last mounting point judgment in #909 is that this is not the last mounting point —that is, there is still another part to be mounted—, the routine returns to #903 and carries out the part adsorption operation for the next mounting point. If the last substrate judgment in #910 is that this is not the last substrate, the substrate (21) is expelled after all the required parts have been mounted, and the routine returns to #902, carries out a feeding operation to feed a new substrate, and repeats the same mounting operation discussed earlier.

DISCLOSURE OF THE INVENTION

The conventional part mounting operation discussed here, however, has problems. Effects such as shrinking the area of the part adsorbing face of nozzles to handle smaller size and higher density parts than before have made it difficult to confirm that there is no deposit on the tip of a nozzle before adsorbing a part or that a part judged to not be in a status allowing mounting has definitely been ejected. Therefore, it is not clearly confirmed in prior art that there is no deposit on the tip of a nozzle or a part has definitely been ejected. Adding dedicated detection devices such as sensors for this confirmation is also difficult due to problems such as space and cost.

Should by any chance an operation for fetching a new part be carried out while a part remains on a nozzle without ejecting, the part remaining without ejecting causes interference by the part to be adsorbed with the adjacent nozzles for adsorbing parts, and obstructs both parts. In extreme cases, the nozzle itself may be damaged.   /7
Furthermore, if even a slight deposit, such as a section of a part, remains on a nozzle, adsorptive power using negative pressure will not work and will be unable to adsorb a new part in the correct posture, causing an obstruction during the next mounting.

In cases such as a part which should have been ejected into the part collecting device (23) in the part collection position (2) has remained unstably adsorbed to a nozzle or a part has moved together with a nozzle while in an abnormal posture, it is entirely possible that this part while moving may fall by mistake onto, for example, the substrate, injuring other already mounted parts or impeding part mounting operations by other nozzles.

This description has discussed a part mounting system of a mode provided with nozzles for adsorbing and holding parts using positive

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and negative air pressure as part holding parts. There are also modes which use mechanical means, such as chucks, to fetch and mount parts. The same problems can arise in these modes if ejection is not carried out correctly and the part or a section of the part remains as a deposit when releasing and ejecting a problem part from a grasped status in the part collection position (22).

Therefore, the purpose of the present invention is to solve problems such as these by providing a part mounting method and a part mounting device for implementing this part mounting method capable of securely recognizing whether a part has been ejected if a part ejected by a part supply device must be ejected for a reason such as an improper holding status, and providing a part mounting method and a part mounting device capable of securely ejecting a part into a specific part collecting device.

Part mounting methods and part mounting devices according to the present invention are designed to solve these problems by using a detection device, preferably already provided in the part mounting device, to detect whether there is any deposit on a part holding part after ejecting a part and before this part holding part fetches the next part; and specifically include the following content:

One mode according to the present invention pertains to a part /8 mounting method for repeating a series of procedures for having a part holding part fetch a part supplied to a part supply part, detecting the holding status of the part on this part holding part, having this part holding part mount this part in a mounting position of a circuit formation if in a status allowing correct mounting as a result of detecting the holding status of this part, and having this part holding part eject this part at a part collection position without mounting this part and fetch a new part if the first part is not in a status allowing correct mounting, which includes a step for detecting whether there is no deposit on a part holding part before this part holding part fetches a new part after having ejected a part judged to not be in a status allowing correct mounting as a result of judging the holding status of this part. Detecting whether a part holding part has been kept clean after ejecting a part which is not in a status allowing mounting prevents any deposit which might remain from impeding the part mounting operation.

Another mode according to the present invention pertains to a part mounting method for repeating a series of procedures for having a part holding part fetch a part supplied to a part supply part, detecting the holding status of the part on this part holding part, having this part holding part mount this part in a mounting position

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of a circuit formation if in a status allowing correct mounting as a result of detecting the holding status of this part, and having this part holding part eject this part at a part collection position without mounting this part and fetch a new part if the first part is not in a status allowing correct mounting, which includes a step for detecting whether there is no deposit on a part holding part before this part holding part fetches a new part just after starting the production operation. Detecting whether a part holding part has been kept clean when starting a production operation prevents any deposit which might remain from impeding the part mounting operation.

Another mode according to the present invention includes a step for detecting whether there is no deposit on a part holding part before this part holding part fetches the first part just after removing a deposit from this part holding part and restarting the production operation if a deposit has been detected as a result of detecting whether there is no deposit on this part holding part. Confirming that a deposit has definitely been removed prevents any deposit which might remain from impeding the part mounting operation.   /9

Another mode according to the present invention uses detection devices for detecting the holding status of a part to detect whether there is no deposit on the part holding part. This can detect a deposit on a part holding part without installing a new detection device.

Another mode according to the present invention pertains to a part mounting method for repeating a series of procedures for having a part holding part fetch a part supplied to a part supply part, detecting the holding status of the part on this part holding part, having this part holding part mount this part in a mounting position of a circuit formation if in a status allowing correct mounting as a result of detecting the holding status of this part, and having this part holding part eject this part at a part collection position without mounting this part and fetch a new part if the first part is not in a status allowing correct mounting, in which it is judged that this part is not in a status allowing correct mounting if the deviation between this part and this part holding part has exceeded a predetermined permissible deviation when detecting the holding status of this part. Predetermining a permissible deviation for a new part to be mounted in a position adjacent to an already mounted part on a circuit formation prevents interference between the already mounted part and a part holding part carrying out a new mounting operation, and increases the density at which parts can be mounted.

Another mode according to the present invention pertains to a part mounting method for repeating a series of procedures for having a part holding part fetch a part supplied to a part supply part, detecting the holding status of the part on this part holding part, having this part holding part mount this part in a mounting position of a circuit formation if in a status allowing correct mounting as a result of detecting the holding status of this part, and having this part holding part eject this part at a part collection position without mounting this part and fetch a new part if the first part is not in a status allowing correct mounting, in which the travel speed of this part holding part is decelerated while moving this part holding part to the part collection position to eject a part if this part has been judged to not be in a status allowing correct mounting as a result of detecting the holding status of this part. This prevents a part which is not held correctly from falling from the part holding part.   /10

Another mode according to the present invention pertains to a part mounting method for repeating a series of procedures for having a part holding part fetch a part supplied to a part supply part, detecting the holding status of the part on this part holding part, having this part holding part mount this part in a mounting position of a circuit formation if in a status allowing correct mounting as a result of detecting the holding status of this part, and having this part holding part eject this part at a part collection position without mounting this part and fetch a new part if the first part is not in a status allowing correct mounting, which includes a step for detecting whether there is no deposit on a part holding part before this part holding part fetches a new part after having ejected a previous part due to this part not being in a status allowing correct mounting as a result of detecting the holding status of this part, a step for having this part holding part fetch the next part to be mounted if this step for detecting whether there is no deposit has confirmed that there is no deposit, a step for stopping the production operation if this step for detecting whether there is no deposit has detected a deposit, and a step for removing the deposit from the part holding part on which this deposit has been detected, restarting the production operation, then having this part holding part fetch the next part to be mounted. Detecting whether a part holding part has been kept clean after ejecting a part which is not in a status allowing mounting prevents any deposit which might remain from impeding the part mounting operation.

Another mode according to the present invention pertains to a part mounting method for repeating a series of procedures for having a part holding part fetch a part supplied to a part supply part, detecting the holding status of the part on this part holding part,

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having this part holding part mount this part in a mounting position
of a circuit formation if in a status allowing correct mounting as a
result of detecting the holding status of this part, and having this
part holding part eject this part at a part collection position
without mounting this part and fetch a new part if the first part is
not in a status allowing correct mounting, which includes a step for
detecting whether there is no deposit on this part holding part
before fetching the first part just after starting operation, a step
for starting fetching a part if this step for detecting whether there
is no deposit has confirmed that there is no deposit, a step for
stopping the production operation if this step for detecting whether   /11
there is no deposit has detected a deposit, and a step for removing
the deposit from the part holding part on which this deposit has been
detected, restarting the production operation, then having this part
holding part fetch the next part to be mounted. Detecting whether a
part holding part has been kept clean when starting a production
operation prevents any deposit which might remain from impeding the
part mounting operation.

Another mode according to the present invention pertains to a
part mounting method for repeating a series of procedures for having
a part holding part fetch a part supplied to a part supply part,
detecting the holding status of the part on this part holding part,
having this part holding part mount this part in a mounting position
of a circuit formation if in a status allowing correct mounting as a
result of detecting the holding status of this part, and having this
part holding part eject this part at a part collection position
without mounting this part and fetch a new part if the first part is
not in a status allowing correct mounting, which includes a step for
comparing the deviation between this part and this part holding part
to a predetermined permissible deviation when detecting the holding
status of this part, a step for mounting this part on a circuit
formation after correcting this deviation if the deviation between
this part and this part holding part is within this predetermined
permissible deviation, and a step for ejecting this part at the part
collection position without mounting this part on a circuit formation
if the deviation between this part and this part holding part has
exceeded the predetermined permissible deviation. Predetermining the
permissible deviation of a part held by a part holding part increases
the density at which parts can be mounted.

Another mode according to the present invention pertains to a
part mounting device provided with a part supply device for supplying
a part to a part supply part, a circuit formation holding device for
adjusting and holding a circuit formation on which this part will be
mounted, a part mounting head for fetching and holding a part from
this part supply part and mounting this part on the adjusted and held

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circuit formation, detection devices for detecting the holding status of a part on the part holding part of this part mounting head after this part mounting head has fetched this part and before mounting this part on the circuit formation, a part collecting device for collecting a part if this part has been judged to not be in a holding /12 status allowing correct mounting as a result of detecting by said detection devices, and feed means for feeding this part mounting head to at least a position for fetching this part, a position for detecting this holding status, a position for mounting this part on a circuit formation, and a position for collecting this part, which has a control part for detecting whether there is no deposit on the part holding part of this part mounting head by the detection devices for detecting the holding status of this part before fetching the next part after a previous part has been judged to not be in a holding status allowing correct mounting as a result of detection by these detection devices and this part mounting head has ejected this part into this part collecting device.

Another mode according to the present invention pertains to a part mounting device provided with a part mounting device provided with a part supply device for supplying a part to a part supply part, a circuit formation holding device for adjusting and holding a circuit formation on which this part will be mounted, a part mounting head for fetching and holding a part from this part supply part and mounting this part on the adjusted and held circuit formation, detection devices for detecting the holding status of a part on the part holding part of this part mounting head after this part mounting head has fetched this part and before mounting this part on the circuit formation, a part collecting device for collecting a part if this part has been judged to not be in a holding status allowing correct mounting as a result of detecting by said detection devices, and feed means for feeding this part mounting head to at least a position for fetching this part, a position for detecting this holding status, a position for mounting this part on a circuit formation, and a position for collecting this part, which has a control part for detecting whether there is no deposit on the part holding part of this part mounting head by the detection devices for detecting the holding status of this part before this part mounting head fetches the first part just after starting the production operation. Confirming that there is no deposit on a part holding part when starting production prevents any deposit which might remain from impeding the part mounting operation.

In another mode according to the present invention, these detection devices detect the deviation between this part and this part holding part, and judge that this part is not in a status allowing correct mounting if this deviation has exceeded a

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predetermined permissible deviation. Predetermining the permissible deviation of a part held by a part holding part increases the density at which parts can be mounted.

In another mode according to the present invention, this part mounting device also contains a deposit removal device for removing a deposit from a part holding part, and this deposit removal device removes a deposit from this part holding part if a deposit has been detected as a result of detecting whether there is no deposit on this part holding part, or a held part has been judged to not be in a holding status allowing correct mounting as a result of detection by the detection devices and this part holding part has ejected this part into the part collecting device. Providing a deposit removal device makes it possible to remove deposits efficiently. This deposit removal device may be any of an air nozzle for blowing compressed air on this part holding part, a vacuum suction nozzle for applying suction in the vicinity of this part holding part, a brush-like member for cleaning this part holding part, or a combination of these.

Another mode according to the present invention pertains to a part mounting device provided with a part mounting device provided with a part supply device for supplying a part to a part supply part, a circuit formation holding device for adjusting and holding a circuit formation on which this part will be mounted, a part mounting head for fetching and holding a part from this part supply part and mounting this part on the adjusted and held circuit formation, detection devices for detecting the holding status of a part on the part holding part of this part mounting head after this part mounting head has fetched this part and before mounting this part on the circuit formation, a part collecting device for collecting a part if this part has been judged to not be in a holding status allowing correct mounting as a result of detecting by said detection devices, and feed means for feeding this part mounting head to at least a position for fetching this part, a position for detecting this holding status, a position for mounting this part on a circuit formation, and a position for collecting this part, which has a control part for decelerating the travel speed of the part mounting head with this part holding part attached while moving this part holding part by these feed means to the part collection position to eject this part if this part has been judged to not be in a status allowing correct mounting as a result of detecting the holding status of this part. This prevents a part which is not held correctly from falling from the part holding part.

Another mode according to the present invention pertains to a /14
computer-readable recording medium recording a program for executing
on a computer a procedure for having a part holding part fetch a part
supplied to a part supply part, a procedure for detecting whether a
part held by this part holding part is in a posture allowing
mounting, a procedure for computing the deviation between this part
holding part and this part and mounting this part on a circuit
formation if this part has been judged to be in a holding posture
allowing correct mounting as a result of this detection, a procedure
for collecting this part at a part collection position without
mounting this part on a circuit formation if this part has been
judged to not be in a holding posture allowing correct mounting as a
result of this detection, a procedure for detecting whether there is
no deposit on a part holding part before this part holding part
fetches a new part after having ejected a part into a part collecting
device, a procedure for having this part holding part fetch the next
part to be mounted if this procedure for detecting whether there is
no deposit has confirmed that there is no deposit, a procedure for
stopping the production operation if this procedure for detecting
whether there is no deposit has detected a deposit, and a procedure
for removing the deposit from the part holding part (14) on which
this deposit has been detected, restarting the production operation,
then having this part holding part fetch the next part to be mounted.
This allows computer control of the procedure for securely removing a
deposit on a part holding part disclosed by the present invention.

This recording medium may also record a program for executing a
procedure for detecting whether there is no deposit on this part
holding part before fetching the first part just after starting
operation, a procedure for having this part holding part fetch a part
if this procedure for detecting whether there is no deposit has
confirmed that there is no deposit, a procedure for stopping the
production operation if this procedure for detecting whether there is
no deposit has detected a deposit, and a procedure for removing the
deposit from the part holding part on which this deposit has been
detected, restarting the production operation, then having this part
holding part fetch the next part to be mounted. Alternately, this
recording medium may also record a program for executing a procedure
for detecting again whether there is no deposit on this part holding
part before this part holding part fetches the next part to be
mounted after restarting this production operation, a procedure for
having this part holding part fetch a part if this procedure for /15
detecting again whether there is no deposit has confirmed that there
is no deposit, and a procedure for stopping the production operation
again if this procedure for detecting again whether there is no
deposit has detected a deposit.

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BRIEF EXPLANATION OF THE DRAWINGS

Fig. 1 is a flowchart showing the flow of the production operation in the part mounting method of a working example according to the present invention.

Fig. 2 is a flowchart showing the flow of the production operation in the part mounting method of another working example according to the present invention.

Fig. 3 is a flowchart showing the flow of the production operation in the part mounting method of still another working example according to the present invention.

Fig. 4 is a block diagram of a part mounting device in a working example according to the present invention.

Fig. 5 is a perspective view showing an outline of a part mounting device according to prior art.

Fig. 6(a) and 6(b) are illustrative diagrams showing an outline of a part mounting device according to prior art.

Fig. 7 is an illustrative diagram showing an outline of the main part of a part mounting device according to prior art.

Fig. 8 is a diagram illustrating a part holding posture judgment method according to prior art.

Fig. 9 is a diagram illustrating a part holding posture detection method according to prior art.

Fig. 10 is a flowchart showing the flow of the production operation in a part mounting method by prior art.

Figs. 11(a) to (c) are perspective views showing examples of deposit removal methods according to working examples of the present invention.

WORKING EXAMPLES

Part mounting methods and part mounting devices according to working examples of the present invention will be discussed referring to the drawings. The following discussion takes the example of rotary type part mounting, in which several part mounting heads are distributed along the circumference of an index for intermittent rotation and mount successively fetched parts on a substrate. The

present invention, however, is not limited to this rotary type part mounting method. For example, the present invention can be applied in the same way to a mounting method using an XY robot system for moving part mounting heads in a plane in both the X and Y directions to fetch and mount parts, or to other mounting methods.

The following discussion also takes the example of part holding parts of a nozzle mode in which part holding parts with part mounting heads attached use positive and negative air pressure to fetch and mount parts on a substrate, but the present invention can be applied in the same way to other part mounting devices which, for example, use mechanical part holding parts such as chucks to fetch and mount parts. The typical example of a substrate is discussed as the piece on which parts are to be mounted, but the present invention can be applied in the same way to mounting parts on other circuit formations besides substrates, such as cases for mounting parts on top of other parts or cases for mounting parts on a box.

Working Example 1

Fig. 1 shows the flow of the production operation of the part mounting method according to a first working example of the present invention, and a part mounting device implementing this part mounting method. The components in the main part of the part mounting device used in this working example are the same as the conventional device discussed referring to Fig. 7. The part mounting method according to this working example detects whether there is no deposit on a nozzle after ejecting a part which is not in a status allowing correct mounting into a part collecting device, and starts adsorbing a part again after it has confirmed that there is no deposit.

The production operation of the part mounting method and part mounting device according to this working example is as follows. As production starts in step #101 (hereafter, "step" will be omitted and only the step # will be indicated) in Fig. 1, a substrate (21) is fed to a circuit formation holding device and adjusted in #102, and a part (3) is adsorbed and fetched from the part supply part (2) in #103. Next, in #104, the part holding posture judgment device (17) judges the holding posture of the part (3) at the part holding posture judgment position (16). If the holding posture of the part (3) is judged to be within a range allowing correct mounting, the routine proceeds to #105, and the judgment device detects the adsorption position of the part (3) at the part holding position detection position (18). If the adsorption position could be detected /17 correctly, the judgement device computes the deviation Δa and the slope α between this adsorption position and the nozzle (14) (see Fig. 9 for both) in #106. In this specification, this judgment of the

holding posture and this detection of the holding position are
collectively called "detection of the holding status." The position
and slope of the held part (3) are corrected based on this deviation
Δa and this slope α. Proceeding to #107, the part is positioned for
mounting on the substrate (21) in the part mounting position (20),
and this part (3) is mounted in #108. Next, #109 judges whether this
is the last mounting point; that is, all parts (3) to be mounted have
been mounted. If judged to be the last mounting point, #110 then
judges whether this substrate (21) is the last substrate. If judged
to be the last substrate, this substrate (21) is expelled in #111 and
the production operation ends.

If the part holding posture judgment in #104 is that the part is
not yet adsorbed, instead of carrying out the mounting operation in
the next part mounting position (20), the routine return to #103 and
repeats the part adsorption operation at the part fetching position
(15) after rotating the index (11) one time. If the part holding
posture judgment in #104 is that the part has been adsorbed upright
or the wrong part has been adsorbed, proceeding to #112, the part (3)
is ejected into the part collecting device (23) in the part
collection position (22). The part (3) is not adsorbed at the part
fetching position (15) during the next rotation of the index (11) in
#113. The part holding posture judgment device (17) confirms that
there is no deposit, such as a part, on the tip of the nozzle (14) in
the part holding posture judgment position (16) in #114. If it was
confirmed that there is no deposit on the nozzle (14) in #115,
returning to #103, this nozzle (14) again fetches adsorbs a part (3).

If a deposit was detected on the nozzle in #115, #116 stops the
part mounting device and/or displays an error message notifying the
operator to this effect or issues an alarm such as lighting a warning
lamp. The operator confirms the status of the tip of the nozzle (14)
on which a deposit was detected, and performs maintenance in #117.
After confirming as okay, the operator presses the production
operation start switch to restart the production operation in #118.
Once the production operation has restarted, after repeating the part
ejection operation in #112, the part adsorption operation is not
carried out at the part fetching position (15) as shown in #113, and
the judgment device again confirms that there is no deposit on the
tip of the nozzle (14) in the part holding posture judgment position
(16) in #114. Thereafter, the operations discussed above are repeated
according to the confirmation result for whether there is or not a   /18
deposit on the nozzle tip in #115.

In a rotary type part mounting device, the rotation of the index
(11) determines the operating sequence of the nozzles (14) attached
to the part mounting heads (12). Therefore, after skipping the

adsorption operation at the part fetching position (15) in #113 as discussed above and reconfirming that there is no deposit on the tip of the nozzle (14) at the part holding posture judgment position (16), adsorbing a part first starts at the part fetching position (15) during the next rotation of the index (11). Incorporating a logic for changing the sequence in which the nozzles (14) are moved in an XY robot system, for example, can set the system so as to move to the part holding posture judgment position (16) first, then to the part fetching position (15) after confirming whether there is no deposit.

In this working example, returning to #112 to reconfirm whether there is no deposit after confirming by the operator, this nozzle (14) does not adsorb a part, and only adsorbs a part after the part holding posture judgment device (17) has reconfirmed that there is no deposit. This avoids operator error due to miniaturization of parts (3), and for added security, uses the part holding posture judgment device (17) to reconfirm that there is no deposit. Part mounting devices which handle parts easily distinguishable by the naked eye may proceed immediately after operator confirmation to the standard operation without this reconfirmation processing.

This working example assumes that a component (10) such as shown in Fig. 7 is used for mounting parts. A part holding posture judgment device (17) confirms at a part holding posture judgment position (16) that there is no deposit on the part holding part (a nozzle (14) in this working example) after ejecting a part (3). Using this part holding posture judgment device (17), which is already provided in the part mounting device, for this detection is highly desirable when trying to avoid problems in terms of costs. Needless to say, however, a new detection device may be provided for this detection.

Working Example 2

Next, Fig. 2 shows the flow of the production operation of the part mounting method according to a second working example of the present invention, and a part mounting device implementing this part mounting method. The part mounting method according to this working example carries out the adsorption operation after confirming that there are no deposits on any of the nozzles. The "start of production" in this case can be selected as desired according to the usual timing involved in starting a production operation; for example, after one substrate has completed production and been replaced by another substrate, or after a new work shift starts. As required, a recognition operation according to this working example may also be carried out at regular intervals after completing production for a specific number of hours. "Just after starting the

production operation" means a timing just after restarting work by turning on power, for example, to part mounting equipment which have temporarily stopped work for reasons such as given above.

After starting production in step #201 in Fig. 2, a substrate (21) is fed to a circuit formation holding device and adjusted in #202. Before starting adsorption of a part (3) in #206, in #203, the part holding posture judgment device (17) is used for one nozzle (14) at the part holding posture judgment position (16) to detect whether there is no deposit on the tip of this nozzle (14). If the judgment device confirmed that there is no deposit on the tip of the nozzle (14) in #204, the judgment device judges whether no deposit has been detected for all the other nozzles (14) in #205. If no deposit has been confirmed for all the nozzles (14), the routine proceeds to #206 and starts the adsorption operation. If whether there is no deposit has not yet been detected for all the nozzles (14), returning to #203, the judgment device carries out the operation for detecting whether there is no deposit on the next nozzle (14), and repeats this until completed for all nozzles (14).

If a deposit was detected on the tip of a nozzle (14) in #204, the routine proceeds to #215 and stops the part mounting device and/or displays an error message notifying the operator to this effect or issues an alarm such as lighting a warning lamp. The operator confirms the status of the tip of the nozzle (14) on which a deposit was detected, and performs maintenance in #216. After confirming as okay, the operator presses the production operation start switch to restart the production operation in #217. Once the production operation has restarted, the part adsorption operation is   /20 not carried out at the part fetching position (15), and the judgment device again confirms that there is no deposit on the tip of the nozzle (14) in the part holding posture judgment position (16) as shown in #203. Thereafter, the operations discussed above are repeated according to the confirmation result for whether there is or not a deposit on the tip of all the nozzles (14) in #205.

After confirming there is no deposit on the tip of any of the nozzles in #205, a part (3) is adsorbed and fetched in #206, and the part holding posture judgment device (17) is used to judge the holding posture of the part (3) at the part holding posture judgment position (16) in #207. If this holding posture is judged to be within a permissible range allowing correct mounting, the judgment device detects the adsorption position and slope of the part at the part holding position detection position (18) in #208. If able to detect this adsorption position and this slope, the judgment device computes the deviation Δa and the slope α between this adsorption position and the nozzle (14) in #209. The position and slope of the held part (3)

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are corrected based on this deviation Δa and this slope α. Proceeding to #210, the part is positioned for mounting on the substrate (21) in the part mounting position (20), and the part (3) is mounted in #211. Next, #212 judges whether this is the last mounting point. If judged to be the last mounting point, #213 then judges whether this substrate (21) is the last substrate. If judged to be the last substrate, this substrate (21) is expelled in #214 and the production operation ends.

If the part holding posture judgment in #207 is that the part is not yet adsorbed, instead of carrying out the mounting operation, the routine returns to #206 and carries out the part adsorption operation again. If the part holding posture judgment in #207 is that the part has been adsorbed upright or the wrong part has been adsorbed, this part (3) is ejected into the part collecting device (23) in the part collection position (22) in #218, and the routine returns to #206 to adsorb and fetch a part (3) again.

As in the previous Working Example 1, the rotation of the index (11) determines the operating sequence of the nozzles (14) attached to the part mounting heads (12) in a rotary type part mounting device, but incorporating a logic for changing the sequence in which the nozzles (14) are moved in an XY robot system can set the system so as to move to the part holding posture judgment position (16) first, then to the part fetching position (15) after confirming whether there is no deposit. /21

Also as in the previous Working Example 1, the reason for reconfirming that there is no deposit after confirming by the operator is to avoid operator error due to miniaturization of parts (3), and the routine may proceed immediately to the adsorption operation in #206 according to circumstances, such as when handling large parts (3). This last discussion took an example having several nozzles (14) attached, but can be applied in the same way if there is only one nozzle (14), In this case, the routine proceeds immediately to the adsorption operation in #206 after confirming that there is no deposit on this single nozzle.

Working Example 2 can be combined with the previous Working Example 1. That is, the following production operation is possible: After starting the production operation, the routine confirms that there is no deposit on the tip of any of the nozzles (14) before adsorbing and fetching a part (3), then carries out the part adsorption operation. Furthermore, if a part (3) has been adsorbed in an upright holding posture, the wrong part has been adsorbed, or the adsorption position of the part (3) could not be detected correctly, the nozzle (14) in question ejects this part, does not adsorb a part

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at the next opportunity, and restarts adsorbing a part (3) after the part holding posture judgment device (17) has confirmed that there is no deposit on the tip of the nozzle (14). As in Working Example 1, using an existing part holding posture judgment device (17) to confirm that there is no deposit on the nozzle (14) is preferred, but needless to say, a new detection device may be provided for this detection.

Working Example 3

Next, Fig. 3 shows the flow of the production operation of the part mounting method according to a third working example of the present invention, and a part mounting device implementing this part mounting method. In the part mounting method and the part mounting device according to this working example, the permissible range of the deviation Δa between the adsorption position of a part (3) and the nozzle (14) has been predetermined, and if this deviation Δa is not within this permissible range, this part (3) is released from adsorption at the part collection position (22) and ejected into the part collecting device (23). After judging that this deviation Δa is not within this permissible range, the travel speed of the nozzle (14) is decelerated until this part (3) has been ejected in the part mounting method according to this working example, and the part mounting device according to this working example has a control part for decelerating the travel speed of this nozzle (14) during this process. Decelerating the travel speed of the nozzle in this way prevents a part (3) which has been adsorbed incorrectly falling by   /22 mistake onto the substrate (21), injuring other already mounted parts (3) or impeding part mounting operations by other nozzles (14).

After starting production in step #301 in Fig. 3, a substrate (21) is fed to a circuit formation holding device and adjusted in #302, and apart (3) is adsorbed and fetched in #303. Proceeding to #304, the part holding posture judgment device (17) judges the holding posture of the part at the part holding posture judgment position (16). If the holding posture judged here is a posture allowing correct mounting, proceeding to #305, the part holding position detection device (19) detects the slope of the adsorption position (31) of the part (3) at the part holding position detection position (18). If the detection device judges that the slope cannot be detected in #306, the detection device computes the deviation Δa between the adsorption position (31) of the part and the nozzle (14) in #307, and judges whether the deviation Δa between the adsorption position (31) of this part (3) and the nozzle (14) is in a predetermined permissible range in #308. If within the permissible range, the position and slope) are corrected based on this deviation Δa and this slope α. Proceeding to #309, the part is positioned for

mounting on the substrate (21) in the part mounting position (20), and the part (3) is mounted in #310. Next, #311 judges whether this is the last mounting point. If judged to be the last mounting point, #312 then judges whether this substrate (21) is the last substrate. If judged to be the last substrate, this substrate (21) is expelled in #313 and the production operation ends.

The permissible deviation for the deviation Δa between the adsorption position (31) of a part (3) and the reference position (32) of a nozzle (14) in prior art (see Fig. 9) was judged as the limit of the visual field of the optical system used to measure this deviation Δa. According to this conventional method, the gap between the part (3) to be mounted and a part already mounted on the substrate imposes a threshold of, for example, about 0.5 mm. If the visual field of the optical system is limited, the mounting position is corrected according to the range which can be captured by this visual field. Therefore, the movement between the nozzle (14) and the substrate (21) is increased after correcting, producing the risk that the tip of the nozzle (14) will contact and damage an already-mounted adjacent part. In the part mounting method according to the present invention, predetermining the permissible range of the deviation Δa as discussed here can restrict this deviation Δa to a smaller range /23 based on the gap between adjacent parts, allowing a next part (3) to be mounted without damaging adjacent parts even if adjacent parts are separated by only a slight gap. The permissible range of this deviation Δa can be set as desired for each part to be mounted according to factors such as the layout of the substrate or the size of the part to be mounted. This method allows the gap between adjacent parts to be reduced, for example, to about 0.2 mm.

If the part holding posture judgment in #304 is that the part is not yet adsorbed, instead of carrying out the mounting operation in the next part mounting position (20), the routine returns to #303 and carries out the part adsorption operation again. If the part holding posture judgment in #304 is that the part has been adsorbed upright, the wrong part has been adsorbed, the adsorption position of the part (3) could not be detected correctly in #306, or the deviation Δa between the adsorption position (31) and the nozzle (14) is greater than the permissible range in #308, the speed of rotational movement of the index (11) moving the nozzle (14) in the arrow direction (13) (see Fig. 7) is decelerated as shown in #314, and the part (3) is ejected into the part collecting device (23) in the part collection position (22) in #315. After completing the part ejection operation in this #315, the routine returns to the original production operation by increasing the speed of rotational movement of the index (11) in the arrow direction (13) until it reaches the correct speed.

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The travel speed of nozzles (14) is decelerated in a rotary type part mounting device by decelerating the rotational speed of an index (11), but the same effect can be obtained in an XY robot system part mounting device by decelerating the drive speed in both the X and Y directions.

The part mounting method according to this working example shown in Fig. 3 showed an example in which a judgment process on whether to mount a part using a permissible range of the deviation Δa between the adsorption position (31) of a part (3) and the nozzle (14) and a process to decelerate the operation until the part is ejected were executed simultaneously. These two processes, however, are independent of each other, and therefore may be executed separately.

Working Example 3 can be combined with the previous Working Examples 1 and 2. That is, a production operation such as the following is possible: The routine confirms that there is no deposit on the tip of any of the nozzles (14) before adsorbing a part (3),   /24 then carries out the part adsorption operation. However, if a deposit has been detected on a nozzle (14), the travel speed of the nozzle (14) is decelerated until it reaches a specific part collection position (22). Furthermore, if a part (3) has been adsorbed in an upright holding posture, the wrong part has been adsorbed, the adsorption position of the part (3) could not be detected correctly, or the deviation Δa between the adsorption position (31) and the nozzle (14) is greater than the permissible range, the travel speed of the nozzle (14) is decelerated, and the part (3) is ejected into the part collecting device (23) at the part collection position (22). After ejecting the part, the travel speed is accelerated until it reaches the correct rotational speed. Just after ejecting a part, the nozzle does not adsorb a part (3) at the next opportunity, and restarts adsorbing a part (3) after the part holding posture judgment device (17) has confirmed that there is no deposit on the tip of the nozzle (14).

Working Example 4

A fourth working example according to the present invention pertains to a deposit removal device for removing deposits on part holding parts. If a deposit is detected on a part holding part in the working examples discussed earlier, the equipment is stopped, the operator performs maintenance such as cleaning on the part holding part to remove the deposit on the part holding part, then the equipment is restarted as shown, for example, in #116 and #117 in Fig. 1. Working Example 4 improves the operating rate of the part mounting device by installing a new deposit removal device to automatically remove deposits instead of this deposit removal

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operation by the operator.

One mode of this deposit removal device uses an air nozzle (41) to blow compressed air as shown in Fig. 11(a). The air nozzle (41) blows compressed air in a position near the part holding part (14) in question to remove the deposit. The direction in which the air nozzle (41) blows this compressed air is preferably from diagonally below the part holding part (14) toward outside the index (11) (see Fig. 7) in order to blow the removed deposit in a direction away from the substrate or other part holding parts after directly applying compressed air to a deposit adhering to the part holding part (14).

Another mode of a deposit removal device uses a vacuum suction nozzle (42) as shown in Fig. 11(b). Bringing this vacuum suction /25 nozzle (42) close to apply vacuum suction to a part holding part (14) on which a deposit has been detected suctions this deposit into this vacuum suction nozzle (42). Using an elastic material such as rubber near the suction hole of the vacuum suction nozzle (42) prevents any damage caused by direct contact between the part holding part (14) and the vacuum suction nozzle (42). A treatment such as planting an elastic material in the form of bristles around this suction hole and fitting this bristle area against the part holding part (14) as shown in Fig. 11(b) allows a deposit to be suctioned and removed more securely. The advantage of using such a vacuum suction nozzle (42) is that such a nozzle can securely collect a deposit while preventing the risk of the deposit flying off and negatively impacting the substrate or other part holding parts.

Another mode of a deposit removal device uses a brush member (43) such as a wire brush as shown in Fig. 11(c). Contacting and sliding this brush member (43) against the surface of the part holding part (14) to which a foreign matter has adhered cleans this part holding part and removes the deposit. The direction in which the brush member (43) slides during this contact is preferably from the center of the index (11) toward the outside in order to prevent the removed foreign matter flying into the substrate or other part holding parts. A net-shaped deposit collection tool, for example, is also preferably installed to prevent the foreign matter removed by the brush member (43) from falling onto the substrate or other parts.

Each of these typical examples of deposit removal devices can remove a deposit without impeding the series of operations involved in mounting parts in a part mounting device from the part adsorption operation to the part mounting operation or part ejection operation, provided that it has been installed in any of the stations from the part collection position (22) to the part fetching position (15) of the index (7) shown in Fig. 7. This deposit removal device can be

placed in a position off to the side, and configured so as to overlap a position allowing this removal operation to be carried out when approached by a part holding part on which a deposit was detected whenever a deposit has been detected. A combination of the deposit removal devices discussed here may also be used.

Installing such deposit removal devices allows a deposit to be removed automatically using these devices without stopping the equipment when a deposit has been detected, which can raise the operating rate of the part mounting device. Using these deposit /26 removal devices can eliminate any possible obstruction by a deposit provided that the part holding part in question does not adsorb a part at the next part fetching position (15), but absorbs a new part after reconfirming at the part holding posture judgment position (16) that the deposit has been removed. It is more efficient to stop the equipment and have the operator perform maintenance only if this reconfirmation has detected that there is still a deposit. A deposit removal device is not limited to use when a deposit has been detected, and may also be used after a part which is not in a status allowing correct mounting has been ejected. Alternately, a deposit removal device may be always used at specific stations, such as stations where there is a great likelihood of a deposit.

If the part holding part is a nozzle which suctions parts, this part suctioning nozzle can be used to remove a deposit instead of installing this deposit removal device. Specifically, nozzles have a conventional configuration which uses negative pressure to absorb a part and positive pressure to release a part. Therefore, after ejecting a part which is not in a status allowing correct mounting or after a deposit has been detected, the part holding part uses this positive pressure to blow compressed air from this nozzle at a higher pressure than when releasing a part, and uses this blowing power to remove the deposit. Because deposits usually adhere to the outside of the air outlet of this nozzle, such a nozzle blowing operation can remove deposits without installing a separate deposit removal device such as discussed earlier. Alternately, a nozzle operating in this way may be used together with this deposit removal device.

A preferred configuration when removing deposits by blowing compressed air from a nozzle in this way is to install a deposit collection tool such as a pleated net at a specific station to prevent deposits removed by this blowing from striking the substrate, and have the nozzle blow when the part holding part in question arrives at this station. Another preferred configuration is to include a procedure for detecting that there is no deposit on this nozzle again after removing a deposit by blowing compressed air before the nozzle adsorbs the next part.

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A fifth working example according to the present invention pertains to a computer-readable recording medium which records a program for executing any of the part mounting methods according to the present invention discussed in the previous working examples. Fig. 4 shows a block diagram of a part mounting device for implementing a part mounting method according to the present invention. This part mounting device is provided with a hardware part containing a part supply part (2), an index (11), part mounting heads (12), a part holding posture judgment device (17), a part holding position detection position (18), and a circuit formation holding device, and a software part containing a part supply operation processing part, an adsorption operation processing part, an angle correction computation part, a holding posture judgment part, a part recognition processing part, a reference position recognition processing part, and a position correction operation processing part. A controller controls the overall operations of these parts. The operations of the components contained in this hardware part are the same as discussed in the previous working examples. The drive parts which enable these operations are shown to the right of each component in Fig. 4. The controller controls the operations of these components based on the processing parts and judgment parts in the software part shown to the left in Fig. 4.

Of these parts, the part supply operation processing part adjusts the amount to move the part supply part (2) so as to position a part (3) to be supplied in the part fetching position. The adsorption operation processing part adjusts, for example, the adsorption timing or amount of adsorption for absorbing a part (3) by the nozzle (14) of a part mounting head (12). The angle correction computation part computes the slope correction (θ rotation) centered on the center axis of the nozzle (14) for a part mounting head (12) to mount a part (3) in a specific position based on the detection result by the part holding position detection device (19). The holding posture judgment part judges whether an adsorbed part (3) is in a status allowing mounting. The part recognition processing part, for example, adjusts the photographic timing and visual field used by the camera devices of the part holding posture judgment device and the part holding position detection device. Finally, after the reference recognition processing part recognizes the reference position of a circuit formation, the position correction operation processing part adjusts the movement amount of the circuit formation holding device.

A computer-readable recording medium according to this working example records a program for executing a part mounting method

according to the present invention by a part mounting device with this configuration. Specifically, this recording medium is a computer-readable recording medium recording a program for executing by sequential time series processing a procedure for adsorbing a predetermined part (3) from the part supply part (2) by one or several nozzles (14), a procedure for detecting whether the adsorption status by this nozzle (or nozzles) (14) is a posture allowing correct mounting, a procedure for carrying out a series of operations for detecting the adsorption position (31) of this part (3), computing the deviation between this nozzle (14) and the adsorption position (31) of this part (3) to correct the position and slope, and mounting this part (3) in a predetermined position on a circuit formation if judged to be in a holding posture allowing correct mounting, a procedure for carrying out a series of operations for collecting this part (3) into a part collecting device (23) at a part collection position (22) without mounting on a circuit formation if judged to not be in a holding posture allowing correct mounting as a result of this detection or this part (3) is not in a status allowing correct part recognition processing, a procedure for detecting whether there is no deposit on a nozzle (14) before this nozzle (14) has adsorbs a next part (3) to be mounted after having ejected a previous part (3) into the part collecting device (23), a procedure for adsorbing the next part (3) to be mounted if this detecting procedure has confirmed that there is no deposit, a procedure for stopping the part mounting device and notifying the operator to this effect if this confirming procedure has detected a deposit, and a procedure for removing the deposit from the nozzle (14) on which this deposit has been detected, restarting the production operation, then adsorbing a part (3) to be mounted to this nozzle (14). The details of these procedures are the same as discussed for the previous working examples, and will not be discussed in detail again.

This computer-readable recording medium can also record a program for executing a procedure for detecting whether there is no deposit on this nozzle (14) before the above procedure for fetching a part (3) from the part supply part (2) by this nozzle (14) just after starting the production operation, a procedure fetching the first part (3) if this procedure for detecting whether there is no deposit has confirmed that there is no deposit, a procedure for stopping the production operation if this procedure for detecting whether there is no deposit has detected a deposit, and a procedure for removing the deposit from the nozzle (14) on which this deposit has been detected, restarting the production operation, then having this nozzle (14) fetch the first part (3) to be mounted.

This computer-readable recording medium can also record a /29
program for executing a procedure for detecting again whether there
is no deposit on a nozzle (14) before this procedure of fetching a
part (3) to be mounted by this nozzle (14) after restarting the
production operation, a procedure for fetching a part (3) by this
nozzle (14) if this procedure for detecting again whether there is no
deposit has confirmed that there is no deposit, and a procedure for
stopping the production operation again if this procedure for
detecting again whether there is no deposit has detected a deposit.

All of these programs can be recorded on a recording medium such
as a floppy disk or a CD-ROM. The part mounting device is provided
with a part capable of reading this recording medium, and this
reading part reads and stores this program in the memory of the
controller. This allows the part mounting device to execute this
program, and by this execution, implement one of the part mounting
methods according to the present invention discussed in the previous
working examples.

This working example was discussed using the mode of nozzles
(14) as part holding parts for adsorbing parts (3), but other modes
of part holding parts such as chucks may be used to grasp parts.

EFFECTS OF THE INVENTION

As discussed above, a part mounting method according to the
present invention and a part mounting device for implementing this
part mounting method can eliminate deposits on the part holding parts
of part mounting heads and completely eject unnecessary parts, and
can confirm this using a detection device. A part holding posture
judgment device already provided in the part mounting device is
preferably used for this detection device rather than adding a new
device. Possibilities if this detection device has detected a deposit
are removal processing by the operator stopping the part mounting
device or automatic removal processing of a deposit by a deposit
removal device using, for example, compressed air or a brush member.
If required, this detection device can be used again afterward to
reconfirm that there is no deposit. This can improve the yield by not
creating unnecessary poor products in the part mounting operation,
and avoid reduction in the operating rate caused by unnecessary /30
obstructions such as damage to part holding parts.

Processing to decelerate the travel speed of a part holding part
through a specific part collection position according to the present
invention can reduce the probability of unexpected loss of a part
even if the holding posture of a part on the part holding part of a
part mounting head remains unstable. As a result, high quality

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circuit formations can be produced more securely when mounting parts on circuit formations using a part mounting method or a part mounting device according to the present invention.

Reading a recording medium according to the present invention by a computer and using this to control part mounting steps can improve the yield by not creating unnecessary poor products in the part mounting operation, and avoid reduction in the operating rate caused by unnecessary obstructions such as damage to part holding parts.

1. A part mounting method for repeating a series of procedures for having a part holding part (14) fetch a part (3) supplied to a part supply part (2), detecting the holding status of the part (3) on said part holding part (14), having said part holding part (14) mount said part (3) in a mounting position of a circuit formation (21) if in a status allowing correct mounting as a result of detecting the holding status of said part (3), and having said part holding part (14) eject said part (3) at a part collection position (22) without mounting said part (3) and fetch a new part (3) if said part (3) is not in a status allowing correct mounting,

including a step for detecting whether there is no deposit on a part holding part (14) before said part holding part (14) fetches a new part (3) after having ejected a part (3) judged to not be in a status allowing correct mounting as a result of judging the holding status of said part (3).

2. A part mounting method for repeating a series of procedures for having a part holding part (14) fetch a part (3) supplied to a part supply part (2), detecting the holding status of the part (3) on said part holding part (14), having said part holding part (14) mount said part (3) in a mounting position of a circuit formation (21) if in a status allowing correct mounting as a result of detecting the holding status of said part (3), and having said part holding part (14) eject said part (3) at a part collection position (22) without mounting said part (3) and fetch a new part (3) if said part (3) is not in a status allowing correct mounting,

including a step for detecting whether there is no deposit on said part holding part (14) before said part holding part (14) fetches the first part (3) just after starting the production operation.

3. A part mounting method according to claim 1 or 2, including a step for detecting whether there is no deposit on said part holding part (14) before said part holding part (14) fetches the first part (3) just after removing a deposit from said part holding part (14) /32 and restarting the production operation if a deposit has been detected as a result of detecting whether there is no deposit on said part holding part (14).

4. A part mounting method according to any one of claims 1 to 3, characterized by using detection devices (17, 19) for detecting the holding status of said part (3) to detect whether there is no deposit

on said part holding part (14).

5. A part mounting method according to any one of claims 1 to 4, including a step for either or both stopping the production operation and/or issuing an alarm if a deposit has been detected as a result of detecting whether there is no deposit on said part holding part (14).

6. A part mounting method for repeating a series of procedures for having a part holding part (14) fetch a part (3) supplied to a part supply part (2), detecting the holding status of the part (3) on said part holding part (14), having said part holding part (14) mount said part (3) in a mounting position of a circuit formation (21) if in a status allowing correct mounting as a result of detecting the holding status of said part (3), and having said part holding part (14) eject said part (3) at a part collection position (22) without mounting said part (3) and fetch a new part (3) if said part (3) is not in a status allowing correct mounting,

characterized by judging that said part (3) is not in a status allowing correct mounting if the deviation between said part (3) and said part holding part (14) has exceeded a predetermined permissible deviation when detecting the holding status of said part (3).

7. A part mounting method for repeating a series of procedures for having a part holding part (14) fetch a part (3) supplied to a part supply part (2), detecting the holding status of the part (3) on said part holding part (14), having said part holding part (14) mount said part (3) in a mounting position of a circuit formation (21) if in a   /33 status allowing correct mounting as a result of detecting the holding status of said part (3), and having said part holding part (14) eject said part (3) at a part collection position (22) without mounting said part (3) and fetch a new part (3) if said part (3) is not in a status allowing correct mounting,

characterized by decelerating the travel speed of said part holding part (14) while moving said part holding part (14) to said part collection position (22) to eject said part (3) if said part (3) has been judged to not be in a status allowing correct mounting as a result of detecting the holding status of said part (3).

8. A part mounting method according any one of claims 1 to 7, having a plurality of said part holding parts (14) distributed along a circumference, and repeatedly fetching, then mounting parts in succession while intermittently moving said plurality of part holding parts (14) along said circumference.

9.   A part mounting method for repeating a series of procedures for having a part holding part (14) fetch a part (3) supplied to a part supply part (2), detecting the holding status of the part (3) on said part holding part (14), having said part holding part (14) mount said part (3) in a mounting position of a circuit formation (21) if in a status allowing correct mounting as a result of detecting the holding status of said part (3), and having said part holding part (14) eject said part (3) at a part collection position (22) without mounting said part (3) and fetch a new part (3) if said part (3) is not in a status allowing correct mounting,

including a step for detecting whether there is no deposit on a part holding part (14) before said part holding part (14) fetches a new part (3) after having ejected a previous part (3) due to said part (3) not being in a status allowing correct mounting as a result of detecting the holding status of said part (3),

a step for having said part holding part (14) fetch the next part (3) to be mounted if said step for detecting whether there is no deposit has confirmed that there is no deposit,

a step for stopping the production operation if said step for detecting whether there is no deposit has detected a deposit, and   /34

a step for removing the deposit from the part holding part (14) on which said deposit has been detected, restarting the production operation, then having said part holding part (14) fetch the next part (3) to be mounted.

10.   A part mounting method for repeating a series of procedures for having a part holding part (14) fetch a part (3) supplied to a part supply part (2), detecting the holding status of the part (3) on said part holding part (14), having said part holding part (14) mount said part (3) in a mounting position of a circuit formation (21) if in a status allowing correct mounting as a result of detecting the holding status of said part (3), and having said part holding part (14) eject said part (3) at a part collection position (22) without mounting said part (3) and fetch a new part (3) if said part (3) is not in a status allowing correct mounting,

including a step for detecting whether there is no deposit on said part holding part (14) before fetching the first part (3) just after starting operation,

a step for starting fetching a part (3) if said step for detecting whether there is no deposit has confirmed that there is no deposit,

a step for stopping the production operation if said step for detecting whether there is no deposit has detected a deposit, and

a step for removing the deposit from the part holding part (14) on which said deposit has been detected, restarting the production operation, then having said part holding part (14) fetch the next part (3) to be mounted.

11. A part mounting method according to claim 9 or 10, having a step for detecting again whether there is no deposit on said part holding part (14) before said part holding part (14) fetches the next part (3) to be mounted after restarting said production operation.

12. A part mounting method for repeating a series of procedures for having a part holding part (14) fetch a part (3) supplied to a part supply part (2), detecting the holding status of the part (3) on said part holding part (14), having said part holding part (14) mount said /35 part (3) in a mounting position of a circuit formation (21) if in a status allowing correct mounting as a result of detecting the holding status of said part (3), and having said part holding part (14) eject said part (3) at a part collection position (22) without mounting said part (3) and fetch a new part (3) if said part (3) is not in a status allowing correct mounting,

including a step for comparing the deviation between said part (3) and said part holding part (14) to a predetermined permissible deviation when detecting the holding status of said part (3),

a step for mounting said part (3) on a circuit formation (21) after correcting said deviation if the deviation between said part (3) and said part holding part (14) is within said predetermined permissible deviation, and

a step for ejecting said part (3) at the part collection position (22) without mounting said part (3) on a circuit formation (21) if the deviation between said part (3) and said part holding part (14) has exceeded the predetermined permissible deviation.

13. A part mounting device provided with a part supply device (7) for supplying a part (3) to a part supply part (2),

a circuit formation holding device for adjusting and holding a circuit formation (21) on which said part (3) will be mounted,

a part mounting head (12) for fetching and holding a part (3) from said part supply part (2) and mounting said part (3) on said

adjusted and held circuit formation (21),

detection devices (17, 19) for detecting the holding status of a part (3) on the part holding part (14) of said part mounting head (12) after said part mounting head (12) has fetched said part (3) and before mounting said part (3) on said circuit formation (21),

a part collecting device (23) for collecting said part (3) if said part (3) has been judged to not be in a holding status allowing correct mounting as a result of detecting by said detection devices (17, 19), and

feed means (11) for feeding said part mounting head (12) to at least a position (15) for fetching said part (3), a position (16) for detecting said holding status, a position (20) for mounting said part (3) on a circuit formation (21), and a position (22) for collecting said part (3),   /36

having a control part for detecting whether there is no deposit on the part holding part (14) of said part mounting head (12) by the detection devices (17, 19) for detecting the holding status of said part (3) before fetching the next part (3) after a previous part (3) has been judged to not be in a holding status allowing correct mounting as a result of detection by said detection devices and said part mounting head (12) has ejected said part (3) into said part collecting device (23).

14. A part mounting device provided with a part supply device (7) for supplying a part (3) to a part supply part (2),

a circuit formation holding device for adjusting and holding a circuit formation (21) on which said part (3) will be mounted,

a part mounting head (12) for fetching and holding a part (3) from said part supply part (2) and mounting said part (3) on said adjusted and held circuit formation (21),

detection devices (17, 19) for detecting the holding status of a part (3) on the part holding part (14) of said part mounting head (12) after said part mounting head (12) has fetched said part (3) and before mounting said part (3) on said circuit formation (21),

a part collecting device (23) for collecting said part (3) if said part (3) has been judged to not be in a holding status allowing correct mounting as a result of detecting by said detection devices (17, 19), and

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feed means (11) for feeding said part mounting head (12) to at
least a position (15) for fetching said part (3), positions (16, 18)
for detecting said holding status, a position (20) for mounting said
part (3) on a circuit formation (21), and a position (22) for
collecting said part (3),

having a control part for detecting whether there is no deposit
on the part holding part (14) of said part mounting head (12) by the   /37
detection devices (17, 19) for detecting the holding status of said
part (3) before said part mounting head (12) fetches the first part
(3) just after starting the production operation.

15. A part mounting device according to claim 13 or 14, wherein said
detection devices (17, 19) detect the deviation between said part (3)
and said part holding part (14), and judge that said part (3) is not
in a status allowing correct mounting if said deviation has exceeded
a predetermined permissible deviation.

16. A part mounting device according to claim 13 or 14,
characterized by stopping the production operation or issuing an
alarm if a deposit has been detected as a result of detecting whether
there is no deposit on said part holding part (14).

17. A part mounting device according to claim 13 or 14, also
containing a deposit removal device for removing a deposit from a
part holding part (14), and said deposit removal device removing a
deposit from said part holding part (14) if a deposit has been
detected as a result of detecting whether there is no deposit on said
part holding part, or a held part (3) has been judged to not be in a
holding status allowing correct mounting as a result of detection by
said detection devices and said part holding part (14) has ejected
said part (3) into said part collecting device (23).

18. A part mounting device according to claim 17, wherein said
deposit removal device contains any of an air nozzle for blowing
compressed air on said part holding part (14), a vacuum suction
nozzle for applying suction in the vicinity of said part holding part
(14), a brush-like member for cleaning said part holding part (14),
or a combination of these.

19. A part mounting device provided with a part supply device (7)
for supplying a part (3) to a part supply part (2),

a circuit formation holding device for adjusting and holding a
circuit formation (21) on which said part (3) will be mounted,   /38

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a part mounting head (12) for fetching and holding a part (3) from said part supply part (2) and mounting said part (3) on said adjusted and held circuit formation (21),

detection devices (17, 19) for detecting the holding status of a part (3) on the part holding part (14) of said part mounting head (12) after said part mounting head (12) has fetched said part (3) and before mounting said part (3) on said circuit formation (21),

a part collecting device (23) for collecting said part (3) if said part (3) has been judged to not be in a holding status allowing correct mounting as a result of detecting by said detection devices (17, 19), and

feed means (11) for feeding said part mounting head (12) to at least a position (15) for fetching said part (3), positions (16, 18) for detecting said holding status, a position (20) for mounting said part (3) on a circuit formation (21), and a position (22) for collecting said part (3),

having a control part for decelerating the travel speed of the part mounting head (12) with said part holding part (14) attached while moving said part holding part (14) by said feed means (11) to said part collection position (22) to eject said part (3) if said part (3) has been judged to not be in a status allowing correct mounting as a result of detecting the holding status of said part (3).

20. A part mounting device according to any one of claims 13 to 19, wherein said feed means (11) are an index with a plurality of part mounting heads (12) distributed on the circumference for feeding said part mounting heads (12) while intermittently moving.

21. A part mounting device according to any of claims 13 to 20, wherein said part holding part (14) is provided with a nozzle for using a vacuum to adsorb and hold a part.

22. A part mounting device according to claim 21, containing a control part for blowing compressed air from the air outlet of a /39 nozzle (14) before said nozzle (14) fetches the next new part (3) after said nozzle (14) has ejected a part (3) which is not in a status allowing correct mounting, or after a deposit has been detected on said nozzle (14) as a part holding part.

23. A part mounting device according to claim 22, having a control part for detecting again whether there is no deposit on said nozzle

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(14) before a nozzle (14) fetches the next new part (3) after blowing compressed air from said air outlet.

24. A computer-readable recording medium recording a program for executing on a computer

a procedure for having a part holding part (14) fetch a part (3) supplied to a part supply part (2),

a procedure for detecting whether a part (3) held by said part holding part (14) is in a posture allowing mounting,

a procedure for computing the deviation between said part holding part (14) and said part (3) and mounting said part (3) on a circuit formation (21) if said part (3) has been judged to be in a holding posture allowing correct mounting as a result of said detection,

a procedure for collecting said part (3) at a part collection position (22) without mounting said part (3) on a circuit formation (21) if said part (3) has been judged to not be in a holding posture allowing correct mounting as a result of said detection,

a procedure for detecting whether there is no deposit on a part holding part (14) before said part holding part (14) fetches a new part (3) after having ejected a part (3) into said part collecting device (23),

a procedure for having said part holding part (14) fetch the next part (3) to be mounted if said procedure for detecting whether there is no deposit has confirmed that there is no deposit,

a procedure for stopping the production operation if said procedure for detecting whether there is no deposit has detected a deposit, and

a procedure for removing the deposit from the part holding part (14) on which said deposit has been detected, restarting the /40 production operation, then having said part holding part (14) fetch the next part (3) to be mounted.

25. A computer-readable recording medium according to claim 24, also recording a program for executing a procedure for detecting whether there is no deposit on said part holding part (14) before fetching the first part (3) just after starting operation,

a procedure for having said part holding part (14) fetch a part (3) if said procedure for detecting whether there is no deposit has confirmed that there is no deposit,

a procedure for stopping the production operation if said procedure for detecting whether there is no deposit has detected a deposit, and

a procedure for removing the deposit from the part holding part (14) on which said deposit has been detected, restarting the production operation, then having said part holding part (14) fetch the next part (3) to be mounted.

26. A computer-readable recording medium according to claim 24 or 25, also recording a program for executing a procedure for detecting again whether there is no deposit on said part holding part (14) before said part holding part (14) fetches the next part (3) to be mounted after restarting said production operation,

a procedure for having said part holding part (14) fetch a part (3) if said procedure for detecting again whether there is no deposit has confirmed that there is no deposit, and

a procedure for stopping the production operation again if said procedure for detecting again whether there is no deposit has detected a deposit.

FIG. 1

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Flowchart:

- Start production #101
- Feed operation #102
- Adsorption operation #103
- #104 Adsorption status OK?
  - OK
  - Not yet adsorbed
  - Adsorbed standing
- Part recognition #105
- #106 Part recognition status OK?
  - OK
  - NG
- Mount positioning #107
- Part mounting #108
- #109 Final mounting point?
  - YES
  - NO
- #110 Final substrate?
  - YES
  - NO
- End production #111

- Part ejection operation #112
- No deposit #113
- No nozzle deposit confirmation operation #114
- #115 No deposit?
  - OK
  - NG
- Part mounting device stopped error display #116
- Nozzle confirmation maintenance by operator #117
- Start SW ON #118

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FIG. 2

Start production #201

Feed operation #202

No nozzle deposit confirmation operation #203

No deposit? #204 — NG

OK

All nozzles OK? #205 — NG

OK

Adsorption operation #206

Adsorption status OK? #207 — Adsorbed standing

Not yet adsorbed

OK

Part recognition #208

Part recognition status OK? #209 — NG

OK

Mount positioning #210

Part mounting #211

Final mounting point? #212 — NO

YES

Final substrate? #213 — NO

YES

End production #214

Start SW ON #217

Nozzle confirmation maintenance by operator #216

Part mounting device stopped error display #215

Part ejection operation #218

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FIG. 3

```
                    ┌─────────────────────────┐
     ┌─────(Start production)#301    │Accelerate index │#316
     │                               └─────────────────────────┘
     │       ┌──────────────────┐             ▲
     │       │  Feed operation  │#302   ┌─────────────────────────┐
     │       └──────────────────┘       │Part ejection operation│#315
     │       ┌──────────────────┐       └─────────────────────────┘
     │       │Adsorption operation│#303          ▲
     │       └──────────────────┘       ┌─────────────────────────┐
     │              #304                 │  Decelerate index │#314
Not yet     Adsorption   Adsorbed standing└─────────────────────────┘
adsorbed    status OK?
              OK
     ┌──────────────────┐
     │ Part recognition │#305
     └──────────────────┘
              #306
          Adsorption
          position          NG
       detection OK?
              OK
     ┌──────────────────┐
     │Nozzle center-part│
     │center deviation  │#307
     │detection processing│
     └──────────────────┘
              #308
           Within
        permissible        NG
        deviation?
              OK
     ┌──────────────────┐
     │Mount positioning │#309
     └──────────────────┘
     ┌──────────────────┐
     │  Part mounting   │#310
     └──────────────────┘
  NO    Final mounting #311
            point?
              YES
  NO       Final      #312
         substrate?
              YES
     (End production)#313
```

FIG. 4

Control
device

Part supply operation
processing part

Part supply
part

— X-axis drive part

—, Part cassette drive part

Index

—,Index rotation drive part

Part mounting
head

— Nozzle up and down drive part

— Nozzle rotation drive part

— Nozzle adsorption operation
drive part

Adsorption
operation
processing part

Angle correction
computation part

Part holding posture
judgment device

— Projector operation
drive part

— Part holding posture
judgment controller

Holding posture
judgment part

Part recognition
processing part

Part holding position
judgment device

— Camera operation drive part

— Part holding posture
recognition controller

Circuit formation
holding device

— Camera operation drive part

— X axis movement drive part

— Y axis movement drive part

Reference position
recognition processing
part

Position correction
operation processing
part

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FIG. 5

FIG. 6

(a)

(b)

FIG. 7

Part holding posture judgment controller 25

Part holding posture recognition controller 26

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FIG. 8

Height
reference face

47

FIG. 9

48

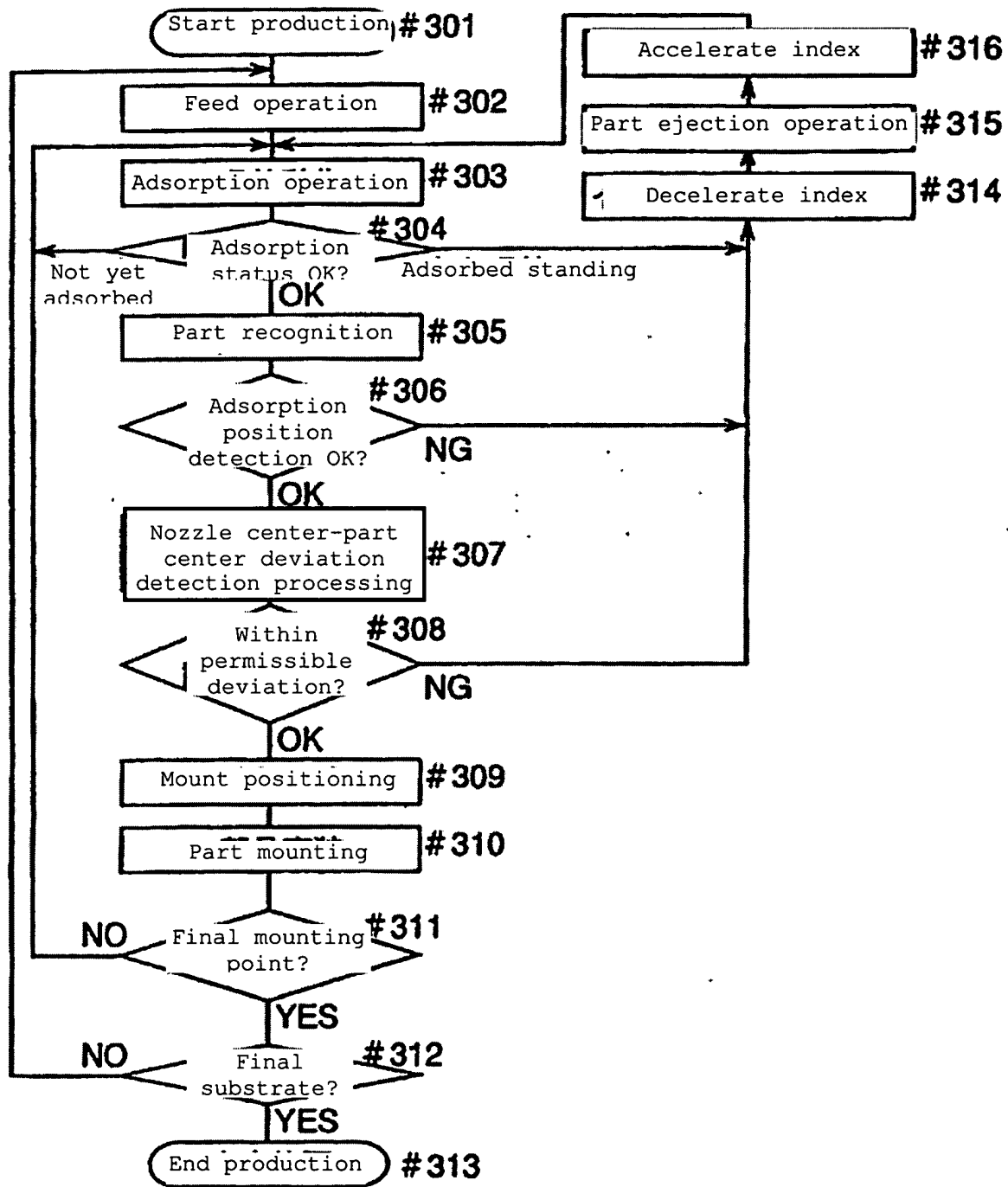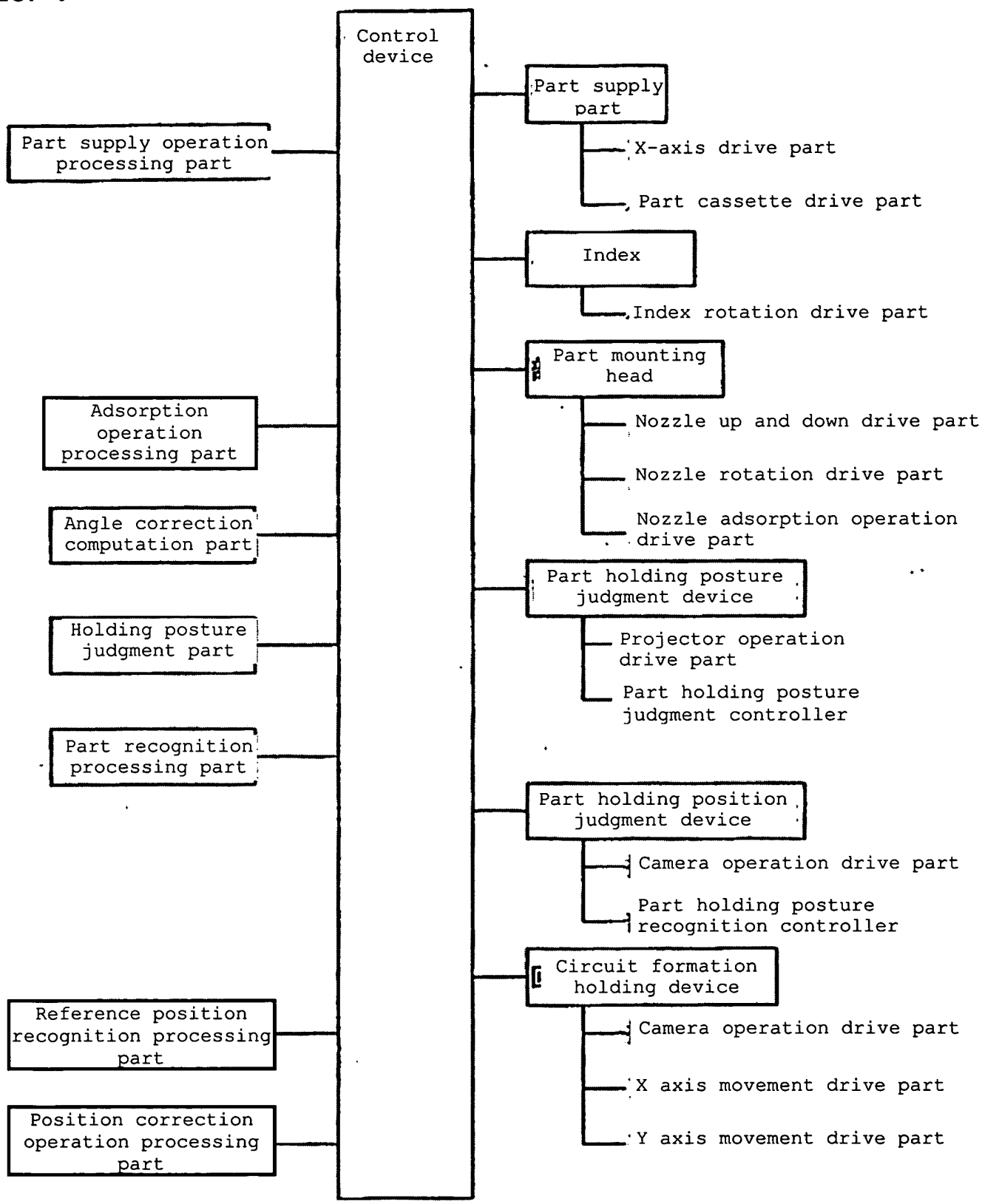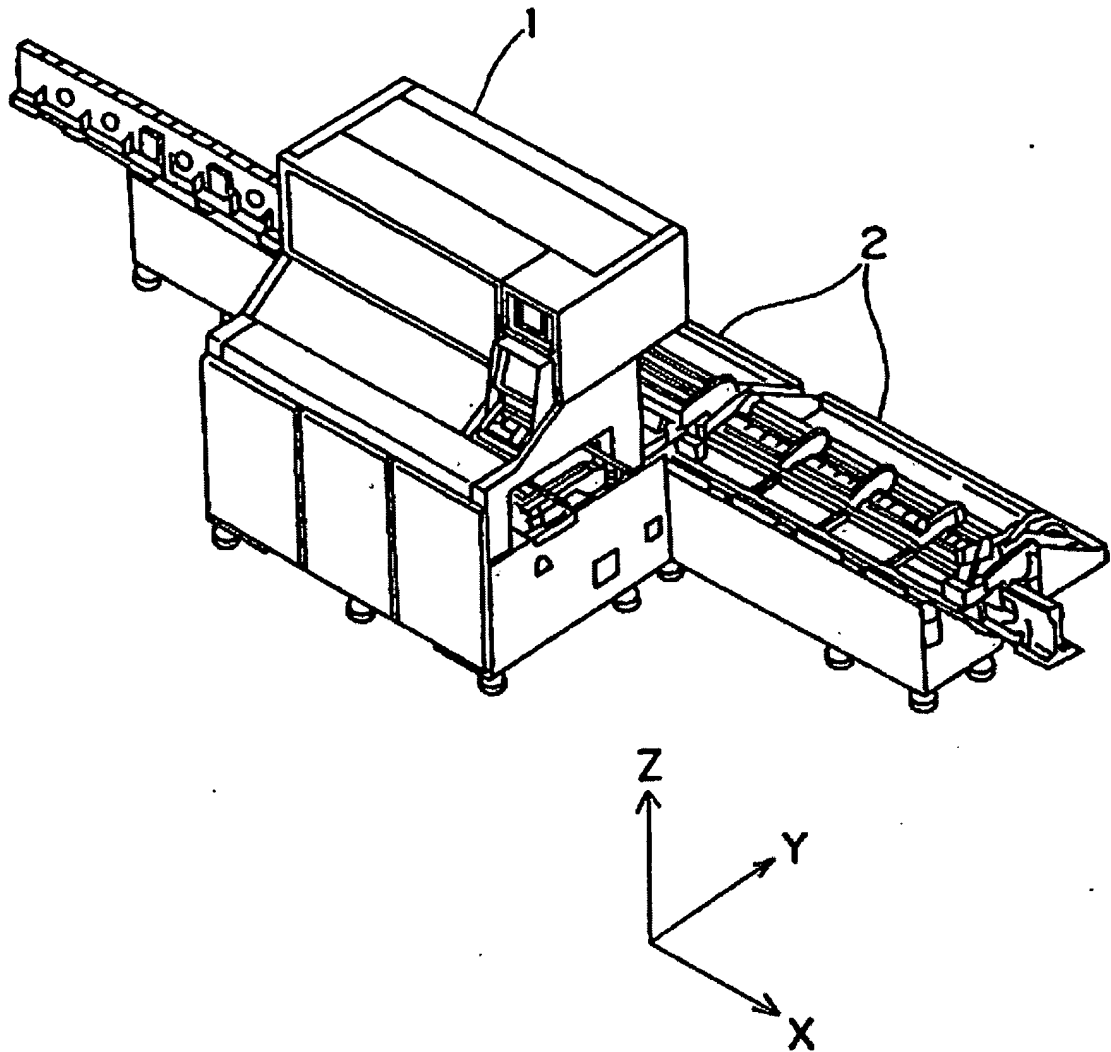X direction

Y direction

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FIG. 10

```
              ( Start production )#901
                        │
                        ↓
              ┌─────────────────────┐
              │    Feed operation   │ #902
              └─────────────────────┘
                        │
        ┌───────────────┼──────────────────────────────────┐
        │               ↓                                   │
        │     ┌─────────────────────┐      ┌──────────────────────────┐
        │     │ Adsorption operation│ #903 │  Part ejection operation │ #912
        │     └─────────────────────┘      └──────────────────────────┘
        │               │ #904                           ↑
        │         ╱─────────────╲                        │
        │  ←─────┤  Adsorption   ├──── Adsorbed standing ─┤
        │ Not yet │ status OK?  │                        │
        │ adsorbed ╲───────────╱                         │
        │               │ OK                             │
        │     ┌─────────────────────┐                    │
        │     │  Part recognition   │ #905               │
        │     └─────────────────────┘                    │
        │               │ #906                           │
        │         ╱─────────────╲                        │
        │        │  Recognition  ├────────────────── NG ─┘
        │        │  status OK?   │
        │         ╲─────────────╱
        │               │ OK
        │     ┌─────────────────────┐
        │     │  Mount positioning  │ #907
        │     └─────────────────────┘
        │               │
        │     ┌─────────────────────┐
        │     │   Part mounting     │ #908
        │     └─────────────────────┘
        │               │ #909
        │         ╱─────────────╲
        │   NO   │ Final mounting │
        └────────┤    point?     │
                  ╲─────────────╱
                        │ YES
                        │ #910
                  ╱─────────────╲
            NO   │    Final      │
        ┌────────┤   substrate?  │
        │         ╲─────────────╱
        │               │ YES
        │      ( End production )#911
```

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FIG. 11

(a)

14

41

(b)

14

42

(c)

14

43